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Respectfuly presented
to Dr. Benj. Rush
by the Auther.

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DISCOURSE,

INTRODUCTORY

TO A COURSE OF LECTURES

ON

Chemistry;

INCLUDING

A VIEW OF THE SUBJECT,

AND

UTILITY OF THAT SCIENCE.

DELIVERED AT

PITTSBURGH, THE SIXTH OF NOVEMBER, 1811.

BY F. AIGSTER, M. D.

TO WHICH IS ADDED

A SYLLABUS

OF A COURSE OF LECTURES ON

CHEMISTRY.

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Mrs. W. Reed Thompson fund

A
DISCOURSE.

GENTLEMEN,

WHEN I behold the place in which I find myself at the present moment; when I consider those who surround me; when I direct my attention to the revolutions of nature and of art which have taken place in this remote corner of the world; when, finally, I consider my own situation among you, and the purpose which has assembled you in this place: every thing fills my mind with wonder and with astonishment. The rude wilderness, which a few years ago, offered a suitable shelter only to the wild beasts of the forest, is changed by the hand of industry, as by magick enchantment, into the comfortable abode of civilized men, and the lofty mountain-oak falls every day under the powerful strokes of the labourer. The copper-coloured Indian has yielded his dwelling to an enlightened race, capable of converting the rich gifts of nature to the comforts and happiness of our species, and of worshipping that true God whose bountiful hand has scattered so many goods over this favoured country.—The unfortunate, who beyond the seas has groaned under the oppression of unrelenting despots, and the more manly and noble spirit who has been reluctant to bend before the arbitrary will of upstart tyrants, find equally a hospitable asylum in the land of freedom, of industry, and of virtue.—And here on the very spot, where ignorance held her iron-sceptre for ages, and where some of you have still witnessed the rude habitation of the barbarous native, I am permitted to proclaim the result of the latest and most astonishing efforts of human genius in one of those sciences, whose influence on human happiness is equally various and important. But whilst I cannot but feel myself flattered with the idea of being the first upon whom this duty is devolved, I must at the same time be sensible of the difficulty of satisfying your just expectations. I might perhaps with much reason expatiate on this difficulty and on the insufficiency of my talents, in order to solicit in my favour your benevolent indulgence; but topicks like these are become rather too trite in our days, and the performance alone will after all either absolve or condemn the undertaking.——You are come, gentlemen, to hear me speak of science—I hasten to fulfil your wishes.

Not less than nearly twenty different definitions have been proposed by different philosophers, in order to determine the nature and the limits of chemistry. Such a disagreement of opinions strikes us with astonishment, especially when we consider, by what rapid strides the science has advanced in our days towards a state of perfection unparalleled in the annals of human knowledge. A nearer consideration of the subject however, will perhaps help us to account for this singularity. Descriptions of complicated subjects will seldom admit of that neatness and precision, which are essential to a good definition, and, indeed, the range of not any science, perhaps, is more comprehensive than that of chemistry. I shall not perplex your minds, gentlemen, with offering to you a detailed and critical review of these different definitions. For our present purpose it will be sufficient to remark, that *Chemistry is that science,* *which investigates and endeavours to ascertain the effects of the action of bodies upon each other, to determine their constituent principles, and to form new compounds.* It is both a science and an art. As a *science*, it teaches the methods of estimating and accounting for the changes produced in bodies by the reciprocal action of their integrant and minutest parts; as an *art*, we should affirm, that it consists in the application of bodies to each other in such situations, as are best calculated to produce these changes.

Until late chemistry was considered as a branch of natural philosophy, an appellation, which, in its most general acception, included all our knowledge concerning the phenomena of nature. A more accurate method of philosophising, has finally fixed the boundaries between the dominions of sister-sciences. All those natural events, which are accompanied by sensible motions, such as to admit of accurate measurement, are now exclusively comprehended in that branch of science, which has long been distinguished by the name of *natural philosophy*, and of late by the more proper appellation of *mechanical philosophy*. But when the distance between two bodies is too small to be perceptible to our senses, and therefore to be measurable, the changes which take place between them fall particularly within the sphere of chemistry.

You will readily perceive, gentlemen, from this first view of the subject, how vast, how extensive is the dominion of chemistry! It embraces almost the whole of natural phenomena, and there is, comparatively speaking, but few changes, which are not attended with some effect, that falls under the consideration of this science. Few branches of human investigation are better calculated to increase our knowledge and to present us with the noblest display of the wisdom and greatness of the author of nature. None perhaps adds more to our resources by extending our dominion over the material world, and by adding to the stock of reasonable and moral enjoyments, which Providence in her bounty has allotted to our species.

In support of these assertions, which to some of you might rather appear exaggerated, you will allow me, gentlemen, to enter upon a few particulars with respect to the different applications of chemical knowledge in private and social life.

Agriculture, this first source of our sustenance, and of our national wealth, is more intimately connected with chemistry, than is usually supposed. Plants, like animals, stand in need of food capable of being assimilated to their proper substance in order to support their existence, and to favour their growth. From the atmosphere, and from the ground, they derive those nutritious principles which are to answer these various purposes. But every soil is not equally adapted to the healthy maintenance of those plants, upon which the sustenance of men in civilized societies principally rests, and it would require all the skill of the intelligent farmer, guided by the light of chemistry, to select the most convenient soil for every kind of grain, to assort the earthy principles in such a manner as may allow vegetation to display itself with all its powers, to apply the most proper manures in due proportions, and to obviate or to cure the diseases of grain and of forage. The art of drying and preserving grain, that of preparing bread, the most convenient manner of disposing stables, the proper choice of water for the drink of domestic animals and many other details of agricultural life, which it would be too tedious to enumerate, are all more or less connected with our science. It must be confessed, however, that chemistry has not yet furnished unerring principles upon which a full theory of farming might be established. The chemist has generally lived too remote from the fields, the only laboratory where we can expect to see chemical agriculture ripen to any degree of perfection, whilst the farmer on the other hand has remained unacquainted with the general doctrines of chemical science. But if there is any country in the world, where we may hope to witness the happy union between science and experimental skill presiding over this first and most useful branch of national industry, it is certainly ours. No other can boast of possessing an equal number of enlightened farmers more free from the shackles of dull routine, than America. What they have done already excites the admiration of every unprejudiced foreigner, and what further improvements are we not entitled to anticipate, after the study of chemistry will have penetrated more generally into this estimable class of our citizens ?

There is another branch of industry, I mean that, which is employed in bringing to light the various riches concealed in the deep recesses of the earth, which in the natural course of things could share but a comparatively small degree of interest in a young country, whose population thinly spread over an immense surface, was compelled by the most necessary wants of life, to direct its first exertions towards clearing wildernesses, and teaching a ground yet unsubdued by the hand of man to bring forth in abundance salutary and nutritious plants. The first generations, that have passed away, have bequeathed to their children as a precious legacy, the care of digging into the bowels of the earth, in order to render them also tributary to the comforts and happiness of man. These lofty hills, whose dark brow overshadows and encircles our luxuriant valley, conceal in their bosom, there is no doubt, besides coal, that precious organic remain of a former world, an extensive stock of hidden treasures, and will yield to the assiduous investigator a rich harvest of useful discoveries and perhaps of riches. But chemistry alone can lead the way in the arduous task. The sagacity of a *Werner*, it is true, has pointed out to us easy and obvious methods to distinguish the different species of minerals by those external characters, which like colour, lustre, fracture, transparency, hardness, specific gravity, &c. strike forcibly our senses, and the genius of a *Hauy* has laid down before our astonished eyes the admirable laws, which nature follows in the work of crystallisation, and which in many instances furnish unerring rules for the distinction of mineral substances. But still, among the immense variety of these substances, some are compounded of such principles and formed under such circumstances and situations in the earth, that it is often difficult if not impossible to distinguish them with certainty, without recurring to the test of reagents and of the crucible. The art of detecting veins of ores can be also obtained only by an accurate knowledge of the component parts of mountains, and of their various stratifications. The dipping wand and divining rod have vanished with so many other superstitions of former ages, and given room to the more certain indications of a philosophical geognosy. Chemical knowledge becomes still more necessary, when the ore is to be converted into a metal useful to the various purposes of life. The most convenient construction of furnaces, the employment of the proper fluxes, the utility of the admission or exclusion of air, as well as many other accessory operations, will all be enlightened by a proper attention to the general doctrines of chemistry.

But the utility of this science is not confined only to those branches of industry, which are employed in producing the raw materials subservient to our wants; its influence on the labours of improving industry is still more conspicuous. " Chemistry," says count Chaptal, one of those men, to whom this science owes many of its happiest applications, " Chemistry is a pharos, which the hand of man has erected in the sanctuary of the operations of art and nature, in order to throw light over all its details." There is indeed, a small number of arts only, in which the principles of chemistry are not more or less concerned. These arts, have existed, it is true, since ages, in the hands of untaught and illiterate men, from whom even they have occasionally received more or less considerable improvements. But can we doubt a moment of the happy influence of scientific skill, after we have seen in our days a Watt, a Wedgewood, a Chaptal, a Seguin, a Paul and others, offering to their respective countries new comforts, and realising in a certain manner the empty dreams of alchemists concerning the philosopher's stone by acquiring honorable riches through the exertion of their scientific talents. On this as on many other occasions a natural bond of union connects theory with practical knowledge. The collection of a long series of facts becomes necessary before any plausible theory can be formed, but as soon as arts have proceeded to this degree of perfection, theory and practice will hand in hand and with a sisterly union advance to mutual improvement, and shed in common their various benefits upon our life.

And what period could be more favourable to the pursuit of these studies in America than the present? A general and almost sudden impulse has awakened the nation to a full sense of the importance of manufactural industry. Enlightened men, though divided by the different tendency of their political opinions, still agree with unanimity, that the time is come, when Americans can shake off the yoke of foreign dependency for a number of the most necessary wants, whose first materials bountiful nature has scattered with lavish hands over this country. The home-manufacturer taking by degrees the place of the foreign consumer of our domestic agricultural produce, will shelter in future our prosperity against the arbitrary oppressions of unprincipled rulers and the ever-changing tides of foreign markets. France herself in the midst of the unhallowed war, which she has carried on for so many years against the nations of Europe, and which has destroyed her own foreign trade, has evinced by her example, the political strength which the culture of this science particularly will impart to any nation, that wishes to be truly independent. "The discovery of the magnet," says the imperial minister of the interior in one of his late reports, "produced a revolution in commerce. Sugar superseded the use of honey, indigo that of pastel. The improvements in chemistry operate at this moment a revolution in an inverse way. It has succeeded in drawing sugar from grapes, the maple and the beet. The pastel which had enriched Languedoç and a part of Italy, but which had not been able in the infancy of that art to bear the competition of indigo, resumes its true superiority. Chemistry extracts from it now a substance, which gives it an advantage over indigo in price and quality." What France has accomplished concerning these few articles, the American commonwealth is enabled to accomplish for nearly the totality of her wants. Her extensive territory including almost every clime and every soil, will furnish the practical chemist with materials for his most ingenious exertions. Our first steps in this new line of activity have succeeded beyond the most sanguine expectations of the patriot, and present us with the fairest prospect of future times. What important part this borough is entitled to claim in these successful undertakings, how great has been the influence of the unwearied labours and the unshaken perseverance of one single man, whom future generations will bless as the founder of your local industry,* I need not recall to the memory of any of you. The career is open, and calls for new endeavours and for new triumphs. But if these are to be obtained to all the extent, which our fond hopes lead us to anticipate, we ought not to be ashamed of following the example of those nations, who by the most ingenious applications of philosophical enquiry have given to the produce of their manufactures a degree of superiority, which opens to them the markets of the world.

We are in possession of an immense quantity of iron-ores and a great number of furnaces are employed in working them. Our tools and utensils in *cast iron*, which formerly had been generally imported from Germany, are now manufactured among us, and the preparation of steel is no more a secret for Americans. Some few more improvements especially depending on chemical principles will impart to these articles a higher degree of perfection, and deliver us finally from the necessity of paying to Britain a tribute for the finer kinds of *steel-ware*.

A laudable beginning has been made in *wool, flax, and cotton manufactures*. But it can never be expected that they will attain any high degree of improvement, as long as the art of *dyeing*, which is altogether chemical, is not properly attended to. Whatever may be the perfection of the tissue, much will still depend on the beauty, the variety, and the durability of colours. Yet no colour can be imparted, but in consequence of the affinity which subsists between the cloth and the dye and the mordant, which is employed as a bond of union between them. Colours, moreover, are liable to vary, if proper attention be not paid to the changes which take place in them by the absorption of oxygen. And who is ignorant of the extensive improvements, which the art of *bleaching*, so nearly allied to that of dyeing has received by the late discoveries in chemistry?

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* Not any inhabitant of Pittsburgh or its vicinity can be doubtful a moment to whom I allude; but as these pages might perhaps fall into the hands of some more remote readers, it will be proper to state, that I mean to speak of Col. James O'Hara, who 14 years ago made the first attempt to introduce manufacturing industry on a large scale in this place by the establishment of a glass-house. The difficulties with which he had to struggle were numerous, but his firm and active mind found means to overcome them all, and to extend gradually the sphere of his enterprising industry.

The soil of the United States abounds with clays, which might furnish the best materials not only for *earthen ware* of various kinds, but also for the most beautiful kinds of porcelain and china, if science did furnish the undertakers with certain principles for the proper mixture of the materials, the degree of heat to be applied and the manner of preparing the finest enamels and varnishes. I am glad to state, that an attempt of manufacturing the finer kinds of earthen ware has been made recently in the eastern states.

A few years past, nothing but common window and green bottle-glass was manufactured in this country. Our own borough is now in possession of several glass-houses, which can fairly supersede any importation of foreign articles in this line, and which in point of perfection of the merchandise leave little or nothing to desire. Still the chemist and the mineralogist may contribute to the further improvement of these establishments by researches directed in this neighbourhood towards the discovery of such necessary materials, which in the present state of things are brought with great expense from distant parts of the country.

The art of *brewing*, which is carried on in America to so vast an extent, is nothing but a mysterious routine, if it be not enlightened by the general doctrines of chemistry. A profound study of the nature and of the various degrees of fermentation will teach the scientific brewer, how to promote or how to check in proper time this fermentation, in order to impart to the beverage the desired qualities. Principles analogous to these may be applied to the *distillation of ardent spirits.* No doubt, but the moralist and the physician will bewail the manifold evils, which the abuse of spirituous liquors is disseminating around us every day. But when it is in the power of neither to banish altogether the very source of these excesses, they both may wish, that in the consumption of this article health and the national capital may be as little impaired as possible. And this can take place only by those chemical improvements, which will impart to our home-manufactured liquors the same degree of perfection, which formerly was the distinguishing quality of the imported merchandise only.

The *tanning of hides* and *preparation of leather*, consist also in processes strictly chemical. Thanks to the labours of some eminent chemists of our days, we are now not only acquainted with the proper nature of the tanning principle, but we know likewise, that this principle exists not only in the bark of a few trees, but that the whole vegetable kingdom is replenished with it. Some practical improvements in the art of tanning deduced from these discoveries have been adopted of late in this country, and there is no doubt but that those inconveniences, which still attend the new method of tanning will be finally removed by a close attention to chemical principles.

The United States can exhibit the finest specimens in the *art of making paper*, but the scarcity of the materials has kept until now at a price considerably high, an article, which for the interests of religion, of morals, of science and of taste can scarcely be at a price sufficiently low. Chemistry may point out perhaps the most suitable means to shorten and to facilitate the various processes of this art, and to find out substitutes for those ingredients, which in the present state of our society are yet comparatively scarce. Mr. Godon of Paris has shewn in a satisfactory manner, that paper of an excellent quality might be fabricated from the *liber* or inner bark of the black mulberry-tree, which the eastern states produce in great abundance.

Soap and candle-making are familiar even to our farmers; but their manner of proceeding in both is rude, and the produce of their industry in this line is highly imperfect. A better knowledge of alkaline and oily substances, and of their mutual action would enable them to give to these articles such qualities as would render them fit for every commercial purpose.

It will be necessary only to mention the *fabrication of mineral acids*, of *alum*, of *nitre*, of *geeen and blue vitriol*, of *white lead*, of *Prussian blue*, of *gun powder*, &c. to make you perceive, that these important branches of industry so suitable to our wants and to our circumstances can be carried on with success only by the help and under the guidance of chemical principles.

You will smile perhaps, gentlemen, if after so many arts and trades, in which public welfare seems to be more or less interested, I am tempted to make a particular mention of the *culinary art*, or *cookery*, as susceptible of being highly benefitted by a clear insight into the general doctrines of our science. It may be indifferent indeed, to the reflecting mind, whether the worn out palate of the epicurean be gratified or not with the enjoyment of new dishes and of new luxuries; but let us not forget, that whilst the refinement of succeeding ages has supplied the tables of the rich only with enervating luxuries, as long as cookery was entrusted exclusively to the hands of the vulgar cook, the philosophical chemist alone has in our days provided for the table of the poor. He has taught starving Indigence how to convert into a substantial food the very bones of animals, which even she had rejected before, and how to extract salutary and nutritious matter from neglected or even from poisonous plants. Will you forgive me, gentlemen, if on this occasion I indulge for a moment my private feelings, by recollecting with heart-felt satisfaction the soothing spectacle, I enjoyed often in the capitals of Europe, when shivering crowds of poor received during the frost of winter, genial warmth and sustenance from the hands of science united with benevolence? Need I tell you, that Count Rumford, your countryman, was the benefactor?

If from the humble walks of common life we extend our views to the higher range of scientific pursuits, we shall see, what a close connection unites chemistry with several of them. Of all others, medicine with its collateral branches has perhaps derived the greatest advantages from this study. It is only since chemistry has been raised to the rank of a real science, that we are acquainted with the nature of the different solid and liquid parts which constitute the human body. Some of the most important functions of our organization, which before had been veiled in impenetrable darkness, are now unravelled and explained. The wonderful process of respiration, by means of which dark venous blood is transformed in the lungs into florid arterial blood, whilst heat and spring are diffused through the whole of our system, has been elucidated by the successive labours and the ingenuity of Lavoisier, Crawford and Bostock. The various and important functions of digestion, secretion, absorption, &c. have also received new light from the philosophical application of our science. But it cannot be denied at the same time, that the manner of considering the human body as a living machine, obeying altogether the same laws of motion and attraction, which are daily exemplified in the productions of human art, has been highly detrimental to the truly philosophical culture of medical science, and has led some men more ardent than cautious to run into bold theories not more congenial to truth than the visionary dreams of the chemiatrical and iatromathematical schools which prevailed in medicine during the seventeenth century. They seem to have overlooked or forgotten, how much the principle of vitality modifies the law of affinity in the living body. On account of this principle, we should be egregiously mistaken, were we to imagine that it is possible to apply and transfer to living bodies the results of action which we observe in dead bodies. This truth was so deeply impressed upon the minds of Stahl and Boerhave, two of the most eminent physicians of the past century, who to an intimate acquaintance with chemistry united a most extensive knowledge of the animal economy, that they abstained from any application of chemistry to the phenomena of the human body. Nevertheless, after all these modifications, an intimate acquaintance with our science will offer to the skilful and cautious practitioner numerous resources to combat some of the most dreadful disorders that can befal the human frame. The deleterious action of poisons on our body, which seems in a great measure to be chemical, will be counteracted and opposed only by such neutralising remedies, which chemistry may afford. It will be principally in consequence of analysis, that efficacious remedies will be found for stony concretions that woful class of diseases, and the recent labours of a Brande and of a Home have already accomplished a great part of this desideratum. Chemical philosophers have acquainted us with some powerful means to check epidemic disorders whose efficacy has been placed beyond any doubt by a number of successful experiments. Chemistry besides, can teach alone the art of preparing and combining remedies, and of applying them with prudence; and we may affirm without hesitation that only in the hands of a physician intimately acquainted with chemistry, the most deadly poisons may be converted into a salutary engine to restore health and vigour.

Every other branch of *natural science* derives the most useful illustrations from the light, which chemistry throws on all the operations of nature. The naturalist as well as the natural philosopher, are seldom allowed to proceed in their respective researches without being obliged to call in the friendly assistance of our science. The theory of light, and the scanty knowledge which we possess of meteorology seem to be divided between the province of the natural philosopher and that of the chemist, and mineralogy has begun to be a satisfactory science only since chemistry itself has became worthy of that name.

But let me suppose for a moment, that your pursuits in life are neither those of the philosopher nor those of the naturalist; the practice of medicine is foreign to you and you enjoy the fruits of the industry of the artisan and the manufacturer, without bestowing any labour upon the production of their various merchandises. Still the study of chemistry will impart to you useful lessons, it will give to your mind a noble employment and raise your faculties to higher and more sublime meditations. The moral and political world exhibit often to our eyes nothing but errours, crimes and anarchy, and the annals of mankind are stained with the blood and sullied with the miseries of millions; every thing on the other hand is order and harmony in the physical world, and the anomalies which we may yet perceive, exist undoubtedly in the imperfection of our knowledge and not in any deficiency of those laws which the great authour of nature has prescribed to the universe. The few truths that we may finally derive from historical and political studies are sad and gloomy and the awful events of our days of which we have been spectators, and some of us the unfortunate sufferers, might induce the most sanguine philanthropist to doubt whether the happiness of our species will ever be promoted by the nicest speculations of the moral and political philosophers, whilst every new fact which we happen to ascertain in the wide dominion of the operations of nature, is a real and permanent conquest, which will contribute to the comforts and the prosperity of succeeding generations.

And glory too awaits in the field of these researches him whose assiduous and deep investigations will gain such a conquest and such triumphs! Can we suppose for a moment that America is incapable of sharing the celebrity which the most civilized nations of Europe have acquired in our days by their chemical discoveries? Is there no Priestley, no Black, no Lavoisier, no Davy to rise among us? Far be from us such an unworthy supposition. The history of chemistry in America is short, but it contains already a few names, which would do honour to the proudest nations of the ancient world. The first course of instructions in chemistry given in America was by *Dr. Benjamin Rush* of Philadelphia, and it was certainly one of the luckiest circumstances for our science to be introduced into this country under the auspices of a man to whom the medical school of this state owes its brightest lustre.— *Dr. Samuel L. Mitchill* of New York, was the first, who on this side of the Atlantick, taught chemistry, according to the principles laid down by Lavoisier and his friends. *Dr. Woodhouse* of Philadelphia, whose loss we deplore, adopted at an early period, the same system, and contributed, perhaps more than any other man, to disseminate in the United States a taste for chemical inquiries, by his excellent lectures, as well as by the different memoirs with which he enriched the science. *Dr. M'Clean* followed meanwhile the same plan in Princeton-College. To *Dr. Seybert* of Philadelphia, to *Mr. Cloud*, and to *Mr. I. Cubush* of the same city, and to *Prof. Silliman* of New-Haven, we are indebted for some able analysses, and *Dr. I. Redman Coxe* has lately evinced his titles to the chair which Dr. Woodhouse had so honourably filled, by offering to the public an ingenious theory of combustion and acidification, of whose intrinsic truth, nevertheless, it would be premature to judge. Many other lovers of scientific pursuits in this country, are now cultivating the study of chemistry in private life, and will perhaps one day enrich this science with precious observations.

It would be unjust and illiberal not to mention in this place, that the arrival of the illustrious *Priestley* in the United States has given to the study of chemistry a considerable spring on this side of the Atlantick. He died indeed, when the leading points of his doctrine had fallen into disuse, and had been treated even by superficial men with a sort of contempt; but his shade will be appeased by the new triumph, which some of his favourite ideas seem to obtain every day, and whatever may be the issue of contested opinions, his memory will always be dear to every lover of science. His friend and biographer Mr. *Thomas Cooper* is at the present moment employed in gaining to chemistry new admirers in a public situation, which I myself have lately resigned.* If in the situation in which I am now placed I could be honoured with the same degree of confidence which my former hearers were so kind to bestow upon me; if I was so happy to give to chemistry a few zealous friends; if I could contribute towards diffusing some knowledge really useful in private and social life, the best of my wishes would be accomplished.

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* A detailed *Narrative of my residence in Carlisle,* &c. &c. will be shortly laid before the public.

END OF THE DISCOURSE.

SYLLABUS

OF A COURSE OF LECTURES

ON

CHEMISTRY.[*]

PART I.

Of the general forces productive of chemical phenomena.

A

OF ATTRACTION.

Attraction considered as a general law of nature—Vain endeavours to account for its cause.—It is of two kinds: 1. Acting at sensible distances; 2. Acting at insensible distances.—The latter is called *chemical affinity*. *Laws of chemical affinity*.

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[*] The following sketch of the course of lectures, which I intend to deliver becomes the more necessary for my hearers; as not any of the existing manuals of chemistry coincide perfectly with the plan which I think necessary to adopt. *Dr. Thomson's elements of Chemistry* deserve the highest recommendation as the latest and the most comprehensive view of this science; but the synthetic order which he has followed is liable to more than one inconvenience. The astonishing discoveries of Professor Davy, which have so much deranged the beautiful symmetry, and shaken the very foundation of the edifice constructed by the French chemists, must convince us, that every attempt at systematical order is as yet premature, and ought to be left to the better fortune and higher advancement of succeeding generations. To the student, moreover, the synthetic method presents many difficul-

1. Chemical affinity takes place only between bodies of a different nature.

2. The agency of chemical affinity is limited to the smallest integrant molecules of bodies.

3. Chemical affinity can exert its action between a number of bodies, simple or compound.

4. Chemical affinity is accompanied by a change of temperature at the instant of its action.

5. The properties characterizing bodies, when separate, are destroyed by chemical combination, and new properties appear in the compound.

6. The agency of chemical affinity existing between two or more bodies may lie dormant until it is called into action by the interposition of another body, which frequently exerts no energy upon any of them in a separate state.

7. The force of chemical affinity between various bodies is different in different substances.

8. Some bodies unite in one definite proportion only; while others again unite in all proportions.

9. The energy of the chemical affinity of different bodies is modified in proportion to the ponderable quantities of the bodies placed within the sphere of action.

ties; he meets at the very threshold of the science with substances, of which he has no previous knowledge, whilst others which nature presents to him every day are withheld for a long time from his attention. The analytic arrangement adopted in the following pages, which *in the general divisions* is that of Dr. Murray, seems to obviate many of these difficulties.

B.

Of Repulsion and the power by which it is produced.

1. OF CALORIC.

Nature and theorems of caloric.—Sources of caloric. 1. Percussion or collision; 2. Compression or friction; 3. The rays of the sun; 4. Chemical action; 5. Electricity and galvanism.*

Expansion of solid, liquid and fluid bodies by heat—Nature of various thermometers—Wedgewood's pyrometer—Propagation of caloric in several *media*—Radiation of caloric—Caloric the cause of liquidity and of fluidity—Dr. Black's latent heat—Frigorific mixtures—Specific caloric—Calorimeter.

2. OF LIGHT.

Physical properties of light.—Dr. Herschel's inquiries and discoveries concerning the rays of light.—Chemical properties of light—Effects of light on vegetables and on animals—Effects of light on metallic oxides and on acids—Phosphori and pyrophori—Photometer.

3. OF ELECTRICITY AND GALVANISM.

Theory of electricity—Electrical attraction and repulsion—Electrical light—Electrical shock—Electricity of the atmosphere—History of galvanism—Its identity with electricity—Theory of Prof. Davy—Chemical agency of galvanism, on water, on metals and metallic oxides, on acids, alkalis and earths—Medical electricity and galvanism.

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* In Mr. Davy's last papers presented to the royal society the names of *Vattaism, Voltaic electricity, Voltaic apparatus,* &c. are generally substituted to those of *Galvanism, Galvanic Electricity, Galvanic apparatus,* &c. Much as I am inclined to respect the merit of Mr. *Vulta* the celebrated nephew of Galvani, whose interesting experiments I had an opportunity of witnessing myself, still the substitution of the name of the improver to that of the original discoverer appears to me an injustice somewhat similar to that which has given to the more happy Americo Vespucii a celebrity, to which the worthy but unfortunate Columbus was exclusively entitled.

PART II.

Of the chemical properties and relations of individual substances.

A.

Chemical constitution of bodies.

1. OF ATMOSPHERIC AIR AND ITS CONSTITUENT PRINCIPLES.

Oxygen.—Various means to obtain oxygen gas.—Properties of oxygen gas: 1. It is not absorbed by water. 2. It is heavier than common air. 3. All combustible bodies burn in it with increased splendour, and it is a necessary requisite in every combustion—Theories of combustion by Lavoisier and Thompson—Dr. Coxe's theory—Lamps with a double current of air explained. —Influence of oxygen gas on vegetables—Theory of respiration—Medical administration of oxygen gas.

Azotic or *nitrogen gas.*—Different manners of procuring it—Properties of nitrogen gas. 1. It is not absorbed by water. 2. It is a little lighter than atmospheric air. 3. It is unfit to support combustion. 4. It is fatal to animal life—Recent experiments and hypotheses concerning the real nature of nitrogen gas—Experiments of Dr. Mark on the medical effects of nitrogen in pulmonary diseases.

Oxygen gas considered in its combination with nitrogen or as *atmospheric air*—Physical properties of atmospheric air—Chemical properties of atmospheric air—Eudiometry and description of various eudiometers.

2. OF WATER AND ITS COMPOSITION.

Of *Hydrogen*.—Various methods of procuring hydrogen gas—Properties of hydrogen gas: 1. It is scarcely absorbable by water. 2. It is inflammable in contact with atmospheric air or oxygen gas—Blowpipe by means of a mixture of hydrogen and oxygen. 3. Hydrogen gas has an unpleasant smell. 4. It is fatal to animal life. 5. It is considerably lighter than atmospheric air—Construction of air balloons and aerostation.

Hydrogen supposed to be the principle which gives inflammability and the cause of metallization.

Water a compound of hydrogen and oxygen—Synthesis or composition of water—Analysis or decomposition of water—Properties and effects of water. 1. Water contains always a certain quantity of air. 2. Water is contained in the atmosphere even during the driest weather—Hygrometry and description of various hygrometers. 3 Water dissolves a great variety of solid bodies. 4. During the solution of bodies in water, a change of temperature takes place. 5. During the solution of salts in water, a quantity of air is disengaged. 6. During the solution of bodies, the bulk of water changes. 7. The solvent power of water increases as the pressure of the atmosphere decreases.

Different states of water as a liquid, as a fluid or in a state of vapour, and as a solid or in the state of ice—Distillation of water—Steam and steam-engines—Papin's digestor—Crystallisation of ice—General ideas on crystallisation—Snow, hail and sleet.

3. OF ALKALIS AND THEIR BASES.

General properties of Alkalis. 1. They change vegetable blue colours to green. 2. They have an acrid and peculiar taste. 3. They are capable of combining with acids and of destroying their acidity. 4. They are readily soluble in water. 5. They corrode animal substances. 6. They serve as the intermedium between oil and water.

On alkalescence in general—Hypothesis of Dr. Coxe.

Of *Ammonia* or *volatile alkali*—Manner of obtaining it—Properties of ammonia. 1. Ammoniacal gas supports neither life nor combustion. 2. It is lighter than atmospheric air; 3. It has a very pungent smell. 4. It is condensed into a liquid by extreme cold. 5. It is decomposed at a high temperature and by the electric spark. 6. It combines readily with water–Action of oxygen on ammonia–Its combinations with sulphur, phosphorus, charcoal and muriatic acid—Its action on metals—Fulminating gold, fulminating silver and fulminating mercury—Medical uses of ammonia.

Researches and hypotheses concerning the composition of ammonia—Experiments of Berzelius, Pontin and Davy.

Of *Potassa.*—Method of preparing pure potassa—Manufacture of pot-ash and pearl-ash—Properties of potassa, 1. It is a brittle substance of a white colour. 2. It has a peculiar smell. 3. Its taste is acid and caustic—Cause of its causticity. 4. It has a very strong affinity for water—Combinations of potassa with sulphur and hydrogen—Its action on metals and their oxides—Various uses of potash, in the arts and in surgery.

Decomposition of potassa by galvanic electricity—Process of Messrs. Thenard and Gay-Lussac—Chemical habitudes of *Potassium.*

Of *Soda.*—Preparation of soda—Analogy between potassa and soda in nearly all their properties—Various uses of soda in the arts.

Decomposition of soda by galvanic electricity—Habitudes of *Sodium.*

3. OF EARTHS AND THEIR BASES.

General properties of *earths.* 1. They are nearly insoluble in water. 2. They have little or no taste and smell; 3. They are fixed, incombustible and incapable of being altered by heat; 4. Their specific gravity never exceeds 4° 9′. 5. When pure they assume the form of a white powder; 6. They are not altered when heated with combustibles.—Analogy between earths and alkalis.

Of *Barytes.*—How prepared—Properties of barytes in its pure form, 1. It has a sharp caustic taste; 2. It changes vegetable blue colours to green; 3. It is strongly poisonous; 4. It serves as an intermedium between oil and water; 5. It absorbs water with great rapidity—Crystals of barytes—Combinations of barytes with sulphur, phosphorus and the metallic oxides.

Decomposition of barytes by galvanic electricity—Habitudes of *Barium.*

Of *Strontites.*—Manner of obtaining it—Properties of strontites; 1. It possesses like barytes alkaline properties. 2. It is readily soluble in boiling water—Crystals of strontites. 3. It burns with a purple red flame. 4. It does not combine with alkalis. 5. It is less fatal to animal life than barytes—Combinations of strontites with sulphur, phosphorus, muriatic acid, and some of the metallic oxides.

Decomposition of strontites by galvanic electricity—*Strontium* the basis of strontites very imperfectly known.

Of *Lime.*—Manner of obtaining it pure—Burning of common lime—Alkaline properties of lime—It is infusible by means of heat—Slacking of lime—Lime water.—Combinations of lime with sulphur, phosphorus and muriatic acid—Its action on metals—Of mortar. Various uses of lime in common life and in medicine.

Decomposition of lime by galvanic electricity—Habitudes of *calcium* or the base of lime yet unknown.

Of *Magnesia.*—Method of extracting it in a pure state—Alkaline properties of magnesia—When pure it is destitute of taste and smell—It has very little affinity for water—Its combinations with sulphur and muriatic acid.

Decomposition of magnesia by galvanic action—*Magnium* or the basis of magnesia very little known.

Of *Alumina*, or *argil.*—Means to obtain it in a pure state—Properties of alumina—Diminution of its bulk by heat. Wedgewood's pyrometer—Effects of water on it—Native crystals of alumina or *sapphire*—Its combinations with charcoal, muriatic acid and metallic oxides—Strong affinity between alumina and the fixed aldalis—Its combination with barytes, strontian and lime—Uses of alumina in dyeing and in the potteries—Probable existence of a metallic base in alumina.

Of *Silex* or *silica.*—Found nearly pure in rock-crystal—Manner of extracting it from quartz—Its properties—Nearly infusible—Nearly insoluble in water—Silicated alkali or liquor of flints—Its combinations with metallic oxides. Art of enamelling and of colouring glasses—Affinity between silica and the fixed alkalis. Glass-making—Combination of silica with other earths. Manufacture of porcelain, of china, &c.—Artificial gems—Combination of silica with fluoric acid.

Silica supposed from analogy to be a metallic oxide.

Of *Zircon* or *zirconia.*—How extracted from the jargon and the hyacinth—Properties of zircon—Combinations of zircon with various substances.

Its constitution probably analogous to that of other earths.

Of *Glucina.*—How obtained from the beryl and the emerald—Its characters—Its constitution.

Of *Yttria.*—How extracted from the gadolinite—Its characters—Its constitution.

5. OF ACIDS AND THEIR BASES.

Of Acids in general.—Properties of acids. 1. They redden vegetable blue colours. 2. They have a peculiar acid or sour taste. 3. They combine chemically with alkalis, earths and oxides, and destroy totally the peculiar properties of these bodies—Cause of acidification—Lavoisier's theory—Dr. Coxe's theory.

A.

NITRIC ACID—NITRATES—NITRITES.

Nitric Acid.—Its preparation for the laboratory—Various ways of separating it from its combinations in large manufacturies—Earths proper for the distillation of saltpetre—Quality of the saltpetre to be employed—Proportions of the ingredients—Manner of conducting the operation—Different qualities of nitric acid.

Properties of nitric acid—Action of water on it—Manner of ascertaining the strength of nitric acid—Its action on simple combustibles—Its combination with muriatic acid. *Aqua regia*—Its action on metals, on alkalis, and on earths—Composition of nitric acid—Importance of nitric acid in the arts and in medicine.

Nitrous Gas or *nitric oxide.*—Manner of obtaining it—Its properties—Compound of nitric acid and nitric oxide or *nitrous acid*—Use of nitric oxide in eudiometry—Its composition.

Nitrous Oxide or *gaseous oxide of azote.*—Various processes for obtaining it—Properties of this gas: 1. It is considerably heavier than common air. 2. Combustible bodies burn in it with a brilliant flame and under very peculiar circumstances. 3. A mixture of this gas with hydrogen detonates loudly when ignited. 4. In a nascent state it enters into combination with alkaline bases. 5. Animals when wholly confined in it, die speedily. 6. It possesses the greatest exhilarating power known, when received into the lungs—Administration of this gas in hypochondriasis—Theory of its composition.

Nitrates. 1. *Nitrate of potash*, or *nitre*—How obtained for the laboratory—Formation of nitre—Lixiviation of nitrified earths—Purification of saltpetre—Properties of nitre—Its crystals—Fulminating powder—Detonation of nitre with charcoal and phosphorus—Action of nitre on metals—Analysis of nitre—Various uses of saltpetre in the arts and in medicine—Fabrication of gunpowder—Description and comparison of the methods employed in making powder.

2. *Nitrate of soda.*—How formed—Properties of this salt—Its crystals—Its use in fire-works.

3. *Nitrate of ammonia.*—How prepared—Properties of this salt—Its crystals—Its solubility—Its explosion at a high temperature. *Nitrum flammans.*

4. *Nitrate of barytes.*—Its preparation—Its properties—Crystals—Solubility—Detonation.

5. *Nitrate of strontites.*—How obtained—Properties mostly analogous to those of the former salt—Crystals—So-

lubility—Blood-red colour imparted by it to the flame of alcohol.

6. *Nitrate of lime.*—Preparation—Properties—Crystals—Strong affinity for moisture—When perfectly dry, it shines in the dark. *Baldwin's phosphorus.*

7. *Nitrate of magnesia.*—Preparation—Crystals—Properties.

8. *Nitrate of alumina.*—Preparation—Crystals—Properties.

9. *Nitrate of glucina.*—Preparation—Properties.

10. *Nitrate of zircone.*—Preparation—Properties.

11. *Nitrate of yttria.*—Preparation—Properties.

Nitrites or combinations of nitrous acid with alkalis and earths—Method of preparing them—Properties of nitrite of potash.

B.

SULPHUR, SULPHURIC ACID, SULPHATES, &C.

Of *Sulphur.*—Native sulphur—Process for extracting sulphur from metallic sulphurets—Raw or stone sulphur—Flowers of sulphur—Sulphur capable of crystallising—Moulding in sulphur—Combination of sulphur with water, alcohol, phosphorus, carbone, the earths, and the metals—Uses of sulphur in medicine and in common life.

Probable composition of sulphur.—Experiments of Berthollet the younger and of Prof. Davy.

Sulphuric acid or *oil of vitriol.*—Rapid combustion of sulphur—Processes for manufacturing it on a large scale. A. By distilling sulphate of iron. B. By the combustion of sulphur—Results of various experiments to effect the combustion of sulphur—Concentration of the acid—

Purification of sulphuric acid for the laboratory—Properties of sulphuric acid—Its consistence and weight—Its great affinity for water—Production of heat by mixing it with water—Strength of the acid at various densities—Its action on simple combustibles, on metals, on alkalis and on earths—Composition of sulphuric acid—Its various uses in the arts, in the laboratory and in medicine.

Sulphurous acid.—Slow combustion of sulphur—Manner of preparing sulphurous acid gas—Properties of this gas—Its combinations—Its composition—How employed in the arts, especially in bleaching.

Sulphates, or combinations of sulphuric acid with alkalis and earths.—General characters. 1. *Sulphate of potash*, or *vitriolated tartar*—How formed—Crystallisation—Properties—Its use in medicine.

2. *Sulphate of soda*, or *Glauber's salt.*—How procured—Form of its crystals—Properties—Solubility in water—Its use in medicine.

3. *Sulphate of ammonia* or *vitriolated ammoniac.*—How prepared—Crystals—Its properties.

4. *Sulphate of barytes.*—Native and artificial—Strong affinity of sulphuric acid for barytes—Crystallisation—Nearly insoluble in water—Various manners of decomposing this salt—Bolognian phosphorus—Composition.

4. *Sulphate of strontites.*—Native and artificial—Analogy between this salt and sulphate of barytes.

6. *Sulphate of lime*, *gypsum*, *Plaster of Paris.*—Native and artificial—Crystallisation—Properties—Its constituent principles—Its uses in the arts and in agriculture.

7. *Sulphate of magnesia*, *epsom salt.*—How extracted and purified—Crystals—Their properties—How decom-

posed—Constituent principles—Uses of sulphate of magnesia in medicine.

8. *Sulphate of alumina.*—How prepared—Its crystals—Sulphate of alumina and potash or *alum*—Native alum—Operation of aluminization—Operations of lixiviation and crystallisation—Various kinds of artificial alum—Properties of alum—Analysis of alum—Phosphorus of Homberg—Importance of this salt in the arts and in medicine.

9. *Sulphate of Glucina.*—How obtained—Properties—Decomposition of this salt.

10. *Sulphate of Zircone.*—Manner of preparing it—Properties—Decomposition.

11. *Sulphate of yttria.*—Preparation—Crystals—Properties—Decomposition.

Sulphites or combinations of sulphurous acid with alkaline and earthy bases.—How obtained—General characters of sulphites.

Sulphurets or binary compounds of sulphur with alkalis and earths.

Manner of preparing alkaline sulphurets, or *livers* of sulphur.—Sulphuret of lime or *Canton's phosphorus*, how prepared—General properties of earthy and alkaline sulphurets. 1. In a moist state they emit an offensive smell, and have a disagreeable taste. 2. They change to green the colour of violets. 3. They blacken animal substances. 4. They are decomposed by all acids. 5. The liquid sulphurets absorb oxygen gas.

Sulphuretted hydrogen gas.—How obtained—Properties of this gas. 1. Its smell is extremely offensive. 2. It is inflammable. 3. It tarnishes silver, mercury and other polished metals. 4. It is readily absorbed by water. 5.

Water, saturated with this gas, turns red the infusion of violets—Other properties of this gas—Metals precipitated by it from their solutions—How decomposed—Constituent principles.

Difficulty of explaining the phenomena presented by sulphuretted hydrogen gas according to the theory of the French chemists.—Hypotheses.

Hydro-sulphurets.—How formed—Properties of hydrosulphurets: 1. They are soluble in water and the solution is colourless. 2. When the solution is exposed to the air, it becomes green or greenish-yellow. 3. After long exposure to the air, the solution becomes liquid and colourless, and on examination is found to contain only the sulphate of the base of the original hydrosulphuret. 4. The solution of the hydrosulphurets precipitates all metallic solutions—Species of hydrosulphurets.

Super-sulphuretted hydrogen and hydroguretted sulphurets.—Super-sulphuretted hydrogen how obtained—Its distinctive characters—Manner of preparing hydroguretted sulphurets—Their distinctive properties—Their employment in eudiometry.

C.

CARBON—CARBONIC ACID—CARBONATES—BINARY COMPOUNDS OF CARBON.

Of *Carbon* or *charcoal.*—Existence of carbon in the three kingdoms of nature—Manner of obtaining pure carbon—Charcoal how made—Circumstances on which the different quality of charcoal depends—Properties of charcoal, 1. It is insoluble in water; 2. It is the most fixed and unalterable of all bodies. 3. It is an excellent conductor of electricity; 4. It is a powerful antiseptic;

5. It absorbs water, air, oxygen and other gases; 6. It is nearly the worst conductor of caloric.

Various states of carbon, as charcoal, diamond and plumbago—Late experiments and researches in order to prove the identity of these substances—Uses of charcoal in sea voyages, in the distillation of spirits, in the purification of water, as a dentrifice, &c. &c. Uses of the diamond—Uses of plumbago.

Carbonic acid.—Produced by the combustion of carbon—Exists in atmospheric air and in minerals—Is produced also by fermentation—found in several states—Mode of extracting it. Its properties: 1. It extinguishes flame; 2. It is fatal to animal life. *La grotta del cane.* 3. It is heavier than common air; 4. It is absorbed by water. Manufacture of artificial mineral waters. 5. Water impregnated with carbonic acid, may be deprived of it by boiling, by freezing and by exposure under the receiver of an air-pump. 6. Carbonic acid gas, when combined with water, reddens vegetable blue colours. 7. It precipitates lime water. 8. It retards the putrefaction of animal substances. 9. It exerts powerful effects on living vegetables—Its combinations with alkalis, earths and metals.

Medical administration of aerated water.

Carbonate.—General characters. 1. *Carbonate of potash*, *salt of tartar*, or *vegetable alkali*—Great affinity of carbonic acid for pure potash—Preparation of the carbonate—Various species of carbonates and subcarbonates of potash—Manner of ascertaining the proportion of the pure alkali—Properties of this salt—Solubility in water—Deliquescence—Decomposition—Distinguishing characters of the carbonate and subcarbonate—Uses of these salts in various arts and manufactures.

2. *Carbonate of soda* or *mineral alkali.*—Native and artificial—How prepared and purified—Its two states as carbonate and sub-carbonate—Its properties—Its uses in medicine and in the arts.

3. *Carbonate of ammonia.*—How formed—Carbonate and sub-carbonate—Properties—Decomposition—Its use in medicine.

4. *Carbonate of barytes.*—Native and artificial—Strong affinity of carbonic acid for barytes—Manner of preparing this salt—Its properties—Decomposition—Its use in medicine.

5. *Carbonate of strontites.*—Native and artificial—Similar in most respects to carbonate of barytes.

6. *Carbonate of lime.*—Native and artificial—Strong attraction of lime for carbonic acid—Its different states in calcareous spar, marble, stalactites, limestone and chalk—Action of heat on carbonate of lime—Fusibility—Analysis—Solubility—Its numerous uses in private life and in medicine.

7. *Carbonate of magnesia.*—How obtained—Constituent parts—Decomposition—Uses in medicine.

8. *Carbonate of glucina.*—How prepared—Properties—Analysis.

The remaining earthy carbonates are uninteresting.

Gaseous oxide of carbon or *carbonic oxide.*—How procured—Properties; 1. It has an offensive smell; 2 It is lighter than common air; 3. It is inflammable; 4. It is sparingly soluble in water; 5. It is fatal to animal life; 6. It detonates when fired with oxygen gas—Analysis of this gas.

Carbonated hydrogen gas.—How formed in nature and by art—Different species of it—Properties of the various species of carbonated hydrogen gas—They are inflammable, but in various degrees—Brilliant combustion of the gas obtained from pit-coal—Apparatus for the substitution of this gas to lamps and candles—Constituent principles of these various gases.

E.

PHOSPHORUS—PHOSPHORIC ACID—PHOSPHATES.

Of *Phosphorus.*—Different methods of preparing phosphorus—History of its discovery—Its properties. 1. It has generally a flesh-colour, but when entirely pure it is as transparent as melted white wax. 2. It yields readily to the knife. 3. It melts with a very gentle heat. 4. In the atmosphere it emits a white smoke, a peculiar smell and a faint but beautiful light. It inflames at a low temperature. 6. It is volatile at 550°—Various modes of oxygenizing it.

Uses of phosphorus.—Phosphoric matches—Late experiments concerning the elementary constitution of phosphorus.

Phosphoric Acid.—Economical method of procuring it—How to obtain it entirely pure—Its properties—Solubility in water—Its decomposition—*Phosphorous acid* and its properties.

Phosphates, or combinations of phosphoric acid with alkaline and earthy bases—General characters—Phosphate of soda introduced into medicine—Phosphate of lime abundant in bones and found in some minerals.

Phosphites, or combinations of phosphorous acid with alkaline and earthy bases—Distinguishing characters.

Binary compounds of phosphorus.—How obtained.

A. *Phosphurets*.—Phosphuret of lime, how prepared—It decomposes water at the common temperature of the atmosphere—Other phosphurets.

B. *Phosphuretted hydrogen gas*.—Manner of preparing it —Properties of this gas. 1. It takes fire immediately in coming into contact with the air. 2. When mixed suddenly with oxygen gas, with oxygenized muriatic gas, or with nitrous oxide, it detonates. 3. Sulphurous acid and phosphuretted hydrogen gases, mutually decompose each other. *Phosphuretted oil* and *phosphuretted ether*.

F.

MURIATIC ACID AND ITS COMBINATIONS WITH ALKALIS.

Muriatic Acid.—How to obtain in it a state of purity as gas—Its properties. 1. It has a pungent smell and is somewhat caustic. 2. When brought into contact with common air, it occasions a white cloud. 3. It does not support combustion nor life. 4. It tinges vegetable blues red. 5. It is heavier than common air. 6. It is rapidly absorbed by water. 7. It effects the liquefaction of ice almost as rapidly as a red hot coal.

Liquid muriatic acid.—How prepared—Its characters. 1. It emits white suffocating fumes. 2. When heated, muriatic acid gas is disengaged. 3. When perfectly pure it is colourless, but its colour is frequently yellowish—Its combinations—Prof. Davy's researches on the constituent principles of muriatic acid.

Muriates, or combinations of muriatic acid with alkalis and earths.—General characters. 1. *Muriate of potash* or *febrifuge salt of Sylvius*—How prepared—Its crystallisation—Its properties—Its constituent parts.

2. *Muriate of Soda* or *common salt*.—Methods of extracting it from sea-water, from salt mines and from saline springs—Its purification—Cause of the deliquescence of some kinds of salt—Properties of muriate of soda—Decomposition of this salt—Analogies—Its uses in private life and in chemistry.

3. *Muriate of Ammonia*, or *salt ammonia*.—Native and artificial—Manner of obtaining it—Process for extracting it from animal matter—Its properties—Analysis—Its uses in dyeing, tinning, and in pharmacy.

4. *Muriate of Barytes*—Manner of preparing it—Properties of its crystals—Decomposition.

5. *Muriate of Strontites*.—Nearly analogous to the former salt.

6. *Muriate of Lime*.---How prepared---Form of its crystals---Properties---*Homberg's phosphorus*---Strong frigorific power of this salt.

7. *Muriate of Magnesia*.--Method of procuring it--Properties---Decomposed by ignition in a high temperature.

8. *Muriate of Alumina*.---How formed---Properties.

9. *Muriate of Glucina*.---Little known.

10. *Muriate of Zircone*.---How prepared---Properties of its crystals---Manner of decomposing it.

Oxygenized muriatic acid and its compounds.---Different ways of forming oxy-muriatic acid---Method of manufacturing it on a large scale---Inconveniences attending the operation and means of remedying them---Method of judging of its quality---Properties of oxy-muriatic acid gas. 1. It has a deep yellow colour. 2. It has a pungent and suffocating smell. 3. It is fatal to animal life 4. It is capable of supporting combustion. 5. It is unalterable by light and caloric. 6. It destroys all vegetable colours. 7. It exerts powerful effects on various combustible bodies. 8. It is absorbed by water, slowly in a quiescent state, rapidly when agitated. 9. The watery solution has not the usual taste of an acid, but an astringent one. 10. Liquid oxy-muriatic acid acquires the colour and peculiar smell of the gas, and has a similar property of discharging vegetable colours---Bleaching by oxy-muriatic acid---Decomposition---Compounds of oxy-muriatic acid---Its various uses for bleaching cotton, linen, thread and yarn, for cleansing old books and prints, and for purifying infected air---Recent researches of Prof. Davy on the oxy-muriatic acid, its nature and combinations---Supposed by him to be a simple body, belonging to the same class with oxygen.

Hyperoxygenized Muriates.---General characters---*Hyperoxymuriate of potash*---Mode of preparing it---Its crystals---Properties of its crystals---Decomposition---Its powerful effect on inflammable bodies---Substituted to nitre in the preparation of gunpowder.

Hyperoxymuriate of Soda.---How obtained---Similar in most of its properties to the former salt.

Hyperoxymuriate of Ammonia.---How procured---Properperties of this salt.

Hyperoxymuriates of barytes, strontites and *lime.*---Use of the latter in bleaching.

Nitro-muriatic Acid or *aqua regia.*---How formed---Its characters---Dissolution of gold and platina in it---Theory of its action.

F.

FLUORIC ACID---FLUATES.

Fluoric acid.---How obtained from fluor-spar---Properties of this acid in its pure form as a gas. 1. It does not support combustion, nor can animals breathe it. 2. It smokes when mixed with the atmosphere, and has a smell similar to that of muriatic acid. 3. It is not altered by exposure to heat or light. 4. It acts powerfully on silica and on glass. 5. Water absorbs it, and the watery solution possesses likewise the property of corroding glass---Engraving on glass by means of fluoric acid---Combination of fluoric acid with vitreous borasic acid. *Fluoboracic acid gas.*

Experimental enquiries concerning the constituent principles of fluoric acid by Davy, Gay-Lussac and Thenard.

Fluates, or combinations of fluoric acid with alkalis and earths.---Alkaline fluates used as tests.

G.

BORACIC ACID---BORATES.

Boracic Acid, or *sedative salt of Homberg.*---How extracted from borax—Form of its crystals—Properties. 1. Its taste is sourish and bitterish. 2. It has no smell. 3. It reddens vegetable blues. 4. It is not altered by light nor heat. Glass of boracic acid. 5. It is very little soluble in water. 6. It is soluble in alcohol, and alcohol containing it burns with a green coloured flame. 7. It effervesces with alkaline carbonates—Its use in medicine —Decomposition of barocic acid by galvanic electricity —Properties of *Boracium* or the base of boracic acid.

Borates, or combinations of boracic acid with alkaline and earthy bases.—*Borate of soda* or *borax*—Found native

—Process for purifying it—Several sorts of it in commerce—*Subborate of soda*—Form of its crystals—Properties of this salt—Its combination with silex and alumina. Artificial gems—Uses of borax as a flux in metallurgic and docimastic operations, for soldering metals and cleansing their surface, in glass-houses, &c.

6. OF METALS.

Of Metals.—Their general characters—Specific gravity—Colour—Hardness— Ductility—Tenacity—-Fusibility—-Crystallisation—Oxidation—-Acidification—Solution—Metallic salts—Revival or reduction of metals—Precipitation—On metallization in general.

Art of essaying mines or *docimasy.*—Art of extracting and of purifying metals in the large way or *metallurgy*—Alloys—Amalgams—Sulphurets, phosphurets, carborets.

Various classifications of metals.—Noble and base metals—Entire metals and semi-metals—Fourcroy's classification. 1. Brittle and acidifiable. 2. Brittle and simply oxydisable. 3. Oxydisable and imperfectly ductile. 4. Ductile and easily oxydable. 5. Very ductile and not easily oxydisable—Dr. Thomson's arrangement of metals. 1. Malleable. 2. Brittle and easily fused. 3. Brittle and difficultly fused. 4. Refractory metals.

A.

MALLEABLE METALS.

Gold.—Mines of gold.—Mode of obtaining it—Various states of the gold of commerce—Its characters and properties—Oxides. 1. Purple by electrical explosions or combustion. 2. Yellow by precipitation of the solution with lime water—Phosphuret of gold—Alloys of gold—Amalgam of gold—Process of cupellation—Salts of gold—Nitromuriate of gold—Its properties—Purple colour imparted by it to various substances—Precipitated by other metals—*Purple of Cassius*—Its use as a paint and to give colour to glass and porcelain—Other means of precipitating gold from its solution. 2. Nitrate of gold—Its properties—Combination of gold with alkalis—Aurate of ammonia or *fulminating gold*—Theory of this phenomenon—Preparations of gold rags for gilding—Various uses of gold.

Silver.—Ores of silver—Various states of the silver of commerce—Characters and properties of silver—Crystallised silver—Oxides of silver—How obtained—Phosphuret of silver—Sulphuret of silver, native and artificial. Cause of the tarnishing of silver—Alloys—Amalgam—Cupellation—Parting—Salts of silver. 1. *Nitrate* or *oxynitrate*—Properties—Crystals—Fused nitrate or *lunar caustic.* Used in surgery and for staining black—Action of light on nitrate of silver—Paintings executed with it—Silvering of ivory—Detonates with combustibles—Is precipitated by other metals—By mercury, *arbor Dianæ*—By copper—Analysis. 2. *hyperoxymuriate of silver*—How obtained—Its properties—Detonates violently with sulphur. 3. *Muriate of silver*—How formed—Its properties—Action of light on it—Fused muriate of silver, *hornsilver*—How decomposed—Analysis. 4. *Sulphate of silver*—How formed—Properties and analysis—Combination of silver with alkalis—Ammoniacal oxide of silver or *fulminating silver*—Theory—Descotils's fulminating silver—Manifold uses of silver and its compounds.

Platina, or *platinum.*—Contaminated commonly with other metals--Count Moussin Poushkin's process for obtaining it pure—Process for working it—Characters and properties of oxides of platinum—How obtained—Phosphuret of platina—Alloys—Salts—*Muriate of platina* How obtained—Properties—Precipitated by various substances—Slow conductor of caloric—Its use in the arts and in philosophical researches.

Iridium.—How obtained from crude platina—Characters and properties—Alloys---*Salts*—Their properties.

Osmium.—How obtained from crude platina—Characters and properties—Oxide—Amalgam—Alloys—Salts unknown.

Rhodium.—How extracted from crude platina—Characters and properties—-Oxide—-Sulphuret—-Alloys—Salts.

Palladium.—How extracted from crude platina—Characters and properties—-Oxide—-Sulphuret—-Alloys—Salts.

Mercury or *quicksilver.*—Ores of mercury—Process of extracting it—Of purifying it—How adulterated in commerce—Characters and properties of mercury—Fluidity—Congelation. Properties of solid mercury—Boiling and sublimation—Of oxides. 1. Black, how obtained—Its use in pharmacy. 2. Red, *red precipitate* how obtained—Properties and uses of this oxide—Sulphuret of mercury, *Æthiops mineral*—*Cinnabar*, native and artificial—*Vermillion.* Various processes for its preparation. Its uses as a paint, &c.—Phosphuretted oxide of mercury—Amalgams—How decomposed—Ammoniacal oxide of mercury or *fulminating mercury* —Salts. 1 *Nitrate* and *oxynitrate.*—How formed without or with heat—Distinctive characters of both salts—Crystallisation—-Causticity—Fusibility—-Detonation—

Decomposition. 2. *Oxymuriate of mercury*, or *corrosive sublimate*.—Various modes of preparing it—Chaptal's process—Characters and properties—Highly poisonous—Forms a triple compound with ammonia—Decomposition—Analysis—Uses in medicine. 3. *Muriate of mercury*, *calomel*, *mercurius dulcis*.—How prepared—Properties—Phosphorescent—Analysis—Its uses in medicine. 4. *Sulphate* and *oxysulphate*.—How prepared—Distinctive characters of both salts—Analysis.

Uses of mercury in the arts, for the construction of thermometers and barometers, &c.

Copper.—Ores of copper—Mode of working the mines of—Characters and properties—Two oxides. 1. Red or orange, natural and artificial. 2. Black.—How formed—Combines with water, *hydrate of copper*—Sulphuret of copper, *aes veneris*—Supersulphuret of copper, *copper pyrites*—Numerous alloys—With arsenic, *white copper*—With zinc in different proportions, *brass pinchbeck*, *gold of Manheim*, &c.—With tin, *bronze*, *bell-metal*, *gun-metal*—Other alloys—Amalgam—Salts. 1. *Nitrate of copper*.—Crystallised—Its properties—Causticity—Action of caloric on it—Detonation—Action on tinfoil—How decomposed—*Blue ashes* used as a paint—Analysis. 2. *Muriated copper*. a. *Oxymuriate*.—How obtained—Properties of its crystals—How decomposed—Analysis. b. *Muriate*—How formed—Crystals—Properties—How decomposed—Analysis. c. *Sulphate of copper, or blue vitriol*.—Process of fabricating this salt for commerce—Its crystals—Properties—Sulphate of copper calcined, efflorescent, dissolved—Action of caloric on it—How decomposed—Constituent parts—Uses. 3. *Carbonate of copper* or *malachites*—Native and artificial—Decomposed by heat. 4 *Acetate of copper* or *verdigris*.—Fabrication of verdigris—Of crystallised verdigris—Characters and properties—Distilled yields acetic acid—Analysis—Its use as a paint. 5. *Arseniate of copper.*—Native and artificial—How prepared—Five varieties—Properties—*Scheele's green*, a beautiful paint—Numerous uses of copper and its combinations in common life, in the arts and sometimes in medicine.

Iron.—*Iron ores*—Manner of working iron ores—Qualities of iron and cause of the difference—General characters—Magnetism—Various states of iron—*Cast-iron*—White cast-iron, grey or mottled cast-iron, and black cast-iron—Properties—How converted into malleable iron—Properties of malleable or *soft iron*—*Wrought iron*—*Oxides*—Two oxides ascertained. a. The *black oxide*, *Æthiops martial*—How obtained—Its use in medicine. b. The *red* or *brown* oxide—How obtained—Base of various colouring substances—Carburet of iron or *steel*—Various modes of manufacturing it—Natural steel—Steel of cementation or blistered steel, tilted steel, German or shear-steel—Cast-steel—Tempering of steel—Phosphuret of iron—Native and artificial—Sulphuret of iron—Native and artificial—Alloys—Salts. 1. *Nitrate of iron*—2 varieties. a. *Nitrate*—How formed—Properties. b. *Oxynitrate*—How formed—Properties. 2. *Muriate of iron*—2 species. a. *Muriate*—How formed—Properties. b. *Oxymuriate*—How formed—Properties. 3. *Sulphated iron*—2 species. a. *Sulphate* or *green vitriol*—Native and artificial—Various modes of obtaining it—Vitriolization—Lixiviation of vitriolised pyrites—Artificial sulphate of iron—Direct combination of sulphuric acid with iron—Properties of this salt—Crystals—Action of heat on it—*Colcothar of vitriol* used in polishing metallic bodies—Black hats converted to the same purpose—Precipitated from its solution by alkaline substances—By galls, different kinds of bark. *Ink making.*—Sympathetic ink—Indestructible ink—Decomposition—Analysis —Use of green vitriol in dyeing and in medicine. b. *Oxysulphate*—How formed—Properties. 4. *Phosphated iron*—2 species. a. *Phosphate*—Native and artificial—How obtained—Properties. B. *Oxyphosphate*—How obtained–Properties. 5. *Carbonate of iron*—Native and artificial—*Iron-rust*—How formed—Properties—Analysis. 6. *Prussiate of iron* or *Prussian blue*, a triple salt—Native and artificial—Fabrication of the salt—Properties—Analysis—Its use in dyeing, &c.—Iron the most useful of all metals.

Lead.—Ores of lead—Manner of working the mines of—Characters and properties—4 oxides. a. The yellow oxide or *massicot*—How formed—Properties—Analysis—Base of all the salts of lead. b. Yellow oxide with a minimum of oxygen—How obtained. 3. *Red lead* or *minium*—How obtained—Its properties—Its use as a paint. 4. *Brown oxide of lead*—Its properties—Vitrification of the oxides of lead—Cupellation—*Refining* of lead—Litharge—Phosphuret of lead—Sulphuret of lead. *Galena*—Alloys—Alloy of lead with tin. Solder of plumbers—*Darcet's alloy*---*White enamel*—Salts. 1. *Nitrated lead*—2 varieties. a. *Oxynitrate*—How obtained—Properties—Analysis. b. *Nitrate*—Properties Analysis. 2. *Muriate of lead*—How formed—Fused muriate, *plumbum corneum*—Analysis—*Submuriate of lead*—Used as a yellow paint. 3. *Sulphate of lead*—Native and artificial—How obtained—Properties—Component parts. 4. *Phosphate of lead*—Native and artificial--How obtained--Properties--Composition. 5. *Carbonate of lead* or *white lead*—Native and artificial—How obtained—Process for manufacturing it in the large way—Properties—Analysis—Used as a paint. 6. *Acitate of lead*—2 varieties. a. *Superacetate* or *sugar of lead*—Processes for obtaining it—Properties—Analysis—Used in dyeing, callico-printing and in pharmacy. B. *Acetate*—How formed—Properties—Solution of the acetate, *Goulard's extract* or *Goulard's water*—Used in surgery. 1. *Chromate of lead*—Native and artificial—How prepared Properties Furnishes a beautiful paint Recapitulation of the various uses of lead and of its compounds.

Tin.--Ores of tin--Mode of essaying mines of--How worked—Species of tin known in commerce—Characters and properties—2 oxides. a. *Yellow*—How formed—Properties.---b. *White oxide*---How obtained---Properties---Enamelling with the oxides of tin---Sulphuret of tin---How formed---Sulphuretted oxide, *aurum musivum*, *musicum* or *mosaicum*---Process for fabricating it —Its beautiful gold-coloured scales used for ornamental purposes and in electricity---Phosphuret of tin---Alloys---With iron, *sheet-tin*, *tinning*---With copper, *gun-metal*, *bell-metal*, *mirror-metal*, *tinned-copper*---Amalgam---*Silvering* of looking-glasses---Salts. 1. *Nitrated tin*---How formed---Properties. 2. *Muriated tin*---2 varieties. A. *Muriate*---How formed---Properties. B. *Oxymuriate*, *smoking liquor of Libavius*---How formed ---Properties---Basis of the scarlet dye. 3. *Sulphate of tin*---How formed---Properties---Uses of tin.

Nickel.—Ores of nickel—How extracted from kupfer-nickel---Characters and properties---Magnetic virtues ---2 oxides of nickel. 1. *Green oxide*---How obtained ---Properties. 2. *Black oxide*—How obtained---Properties---Phosphuret and sulphuret of nickel---Alloys imperfectly known---*Salts*. 1. *Nitrate of nickel*---Preparation---Properties---Analysis. 2. *Muriate*---Preparation ---Properties---Composition. 3. *Sulphate*---Properties and composition.

Zinc.[*]---Ores of zinc---Process of obtaining the metal from the ore---Characters and properties--Affinity of zinc for oxygen---2 oxides. 1. *White oxide*, *flowers of zinc*, *nihil album*, &c.---Obtained by combustion---Properties. 2. *Flesh-coloured oxide*---How obtained---Composition---Combination with hydrogen---Phosphuret---Sulphuret, native and artificial, *blende*---Alloys---*Brass*, *pinchbeck*, &c.---Amalgam used in electricity---Salts. 1. *Nitrate of zinc*---Properties. 2. *Muriate of zinc*---Properties. 3. *Sulphate of zinc*, *white vitriol*---Properties---Composition---Its use in medicine and in surgery. 4. *Carbonqte of zinc*---Artificial and native. *Calamine.*

B.

METALS THAT ARE BRITTLE AND EASILY FUSED.

Bismuth.---Ores of bismuth---Working of the ores---Characters and properties---Yellow oxide obtained by combustion---Composition--Properties---Sulphuret of bismuth—Beautiful crystallisation—Composition—Alloys ---Amalgam---Darcet's fusible metal---Salts. 1. *Nitrate.* Properties---*Subnitrate* or *pearl white*---How obtained Its use as a paint, and since late in medicine. 2. *Muriate*—How obtained—Properties—-Sublimation, *butter of bismuth.* 3. *Sulphate.*—Preparation and properties—Sympathetic ink.

Antimony.—Ores of antimony—Working of the ore—Characters and properties--2 oxides. a. *Yellowish white* oxide—How obtained. b. *White oxide* or *argentine flowers of antimony*—Formed by combustion—Properties—Sulphuret of antimony—Native and artificial—

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[*] The malleability of zinc, when heated, has been very lately ascertained.

Combinations of the yellowish white oxide with the sulphuret, *glass of antimony*, *crocus metallorum*, *lime of antimony*—Great variety of processes for obtaining these compounds—Triple compound of the sulphuret with potash, *Kermes mineral*—*Golden sulphur of antimony*—-Phosphuret of antimony—-Alloys—Antimony and lead, *printer's types*—Salts. 1. Nitrate of antimony. 2. Muriate of antimony, *butter of antimony*—How formed—Properties—*Powder of Algaroth.* 3. Sulphate of antimony—How formed—Properties. 4. Phosphate of lime and antimony, *Dr. James's powder*—Dr. Pearson's analysis—Formula of Mr. Chenevix for preparing this powder. 5. Tartrate of antimony and potash, *antimoniated tartar*, *tartar emetic*—Modern process of forming this salt—Properties—Composition—Extensive use of antimony and its compounds in medicine and in some arts.

Tellurium.—Ore—How extracted—Characters and properties—White oxide—How obtained—Properties—Action of tellurium on water, *telluretted hydrogen*—Sulphuret of tellurium—Amalgam—Alloy of tellurium and potassium—Salts—General properties.

Arsenic.—Ores—How obtained—Characters and properties—2 oxides. a. White oxide, *arsenious acid*, *white arsenic*—Native and artificial—Properties. b. Arsenic acid—Process for preparing it—Prroperties—Arsenical hydrogen gas—How prepared—Properties—Sulphurets. a. Red sulphuret, *realgar*—Native and artificial—Properties—Used as a paint. b. Yellow sulphuret, *orpiment*—Native and artificial—Properties—Phosphuret of arsenic—Alloys—With copper, *white copper*, *white tombac*, much used in China—With iron, native, *mispickel*—Amalgam—Salts—Arseniate of cobalt, native—Uses of arsenic in dyeing, &c.—Dangers attending it.

C.

BRITTLE AND DIFFICULTLY FUSED METALS.

Cobalt.—Ores of cobalt—How obtained from the ore—Characters and properties—Magnetic power—3 oxides. a. blue oxide—How formed—Properties. b. Olive green How obtained—Properties. c. Black—How obtained—Properties—*Zaffre*—*Blue smalt*—Sulphuret—Phosphuret—Alloys—Natural and artificial—Salts—Muriate of cobalt—How formed—Forms the best of all sympathetic inks—Use of cobalt for colouring starch, enamels, porcelains and glasses.

Manganese.—Ores—Characters and properties—Strong affinity for oxygen—3 oxides. a. White—How obtained. b. Red—How obtained. c. Black—Native—Its use for obtaining oxygen gas—Phosphuret—Sulphuretted oxide of manganese—Black oxide with borate of soda—With nitrate of potash, *mineral cameleon*—Alloys—Salts—Solutions in sulphuric and phosphoric acids, rose coloured—Effects of light on these solutions—Salts—Uses of manganese in glass-houses and in the fabrication of oxy-muriatic acid.

Chrome, or *chromium.*—Ores of chrome—Characters and properties—3 oxides. a. Green—How obtained. b. Brown. c. Red or orange, chromic acid—Native—Chromic acid with potash—With mercury—With silver—With copper—With borax—Variety of beautiful colours produced by these combinations—Action of the acids on chromium—Uses of this metal as a pigment, for colouring enamels, porcelains and glasses.

Molybdena, or *molybdenum.*—Ore—How extracted—Characters—4 oxides. a. Brown. b. Violet-brown. c. blue. d. White, molybdic acid—How obtained—Properties---Sulphuret of molybdena, native---Alloys---Action of acids on it---Combination with alkalis and earths.

Uranium.---Ore---How extracted---Characters---2 Oxides a. Greyish black obtained by combustion. b. Yellow----How obtained --Properties---Soluble in nitric acid---May be used to colour glass.

Tungsten.---Ores---How obtained---Characters---2 oxides. a. blue. b. Yellow or tungstic acid---How obtained---Properties.

D.

REFRACTORY METALS.

Titanium.---Ores---How extracted---Characters---3 oxides. a. The blue or purple. b. The red, native---Properties. c. The white---Phosphuret---Soluble by acids---Titanium used in the manufacture at Sevres to colour porcelain.

Cerium.---Ore---How procured as pure oxide---Difficultly reduced---Its characters---2 oxides, the white and the brown----Alloy with iron---Action of acids on it---Salts.

Tantalium.---Ores---How obtained---Characters---Oxides ---Insolubility in acids.

Columbium.---Ore---Attempts to reduce it---Properties---Phosphuret.

PART III.

Chemical Examination of Organised Nature.

A.

VEGETABLE SUBSTANCES.

Structure of vegetables---Root, stem, leaves, flowers, fruits, seed---General observations on the analysis of vegetable substances. 1. *Vegetable extract.*---How obtained---Properties---Soluble in alcohol and in liquid alkalis, but not in acids---Affinity for alumine---How made use of in dyeing---Precipitated by several metallic salts.

2. *Mucilage* or *gum.*—Nature and properties—Soluble in water and insoluble in alcohol—Precipitated by some metallic salts—Soluble in pure alkalis—Action of acids on it—Combination of gum and sugar—Results of destructive distillation.

3. *Vegetable jelly.*—How obtained—Properties—Its use in confectionary.

4. *Sugar* and *oxalic acid.*—a. *Sugar*—Abounds in vegetables—Difference between the saccharine juices of vegetables and sugar—Manna—Maple sugar—Grape sugar—Beet sugar—Sugar cane—Manufacture of sugar at the mill—Raw sugar—Clayed sugar—Refining of raw sugar—Properties of sugar. 1. It is soluble in water and in alcohol. 2. Lime water renders sugar more soluble; alkalis unite with it and destroy its taste. 3. It renders oils miscible with water—Action of sulphurets, hydrosulphurets and phosphurets—Results of destructive distillation—Composition—Uses of sugar.

b. *Oxalic acid.*—How obtained from sugar and other vegetables—Characters—Action on vegetable blue colours—Combination with alkalis and earths—Oxalate of potash—Strong affinity for lime—Excellent test of that earth—Its use in the arts.

5. *Native vegetable acids and acidula.*—General characters.

a. *Citric acid.*—Vegetables in which it is found—Process for obtaining it—Characters and properties—Uses.

b. *Gallic acid.*—Plants in which it is found—Process of extracting it—Not easily obtained perfectly pure—Characters—It precipitates most metals from their solutions—Basis of ink—Test of iron.

c. *Malic acid.*—Vegetables in which it is found—How obtained—Properties.

d. *Tartarous acid*, and *tartrites*—How obtained—Characters—Combination with alkalis—Tartrite of potash—Supertartrite—Its use in medicine.

e. *Benzoic acid*, or *flowers of Benjamin*—How obtained—Properties.

f. *Moroxylic acid.*—Characters not yet fully ascertained.

g. *Laccic acid.*—Substance from which it is obtained—Properties.

6. *Fixed oils.*—Vegetables from which they are obtained—Method of obtaining fixed oils—Process for clarifying oils—General characters—Rancidity of oils—Combination with alkalis—*Soaps*—Solid soap—Preparation of the leys—Boiling of hard soap—White soap—Marbled soap—Soaps formed without heat—Domestic soaps—Properties of soap—Combination of oils with sulphur and phosphorous—With metallic oxides—Drying oils—Process for making drying oils—*Printer's ink*—Plasters—Component principles of oils—Uses of fixed oils.

7. *Volatile or essential oils.*—Method of extracting them—Adulteration of volatile oils—Difference in their colour, consistence, gravity and odour—Properties of volatile oils—Uses—*Camphor*—In what different from volatile oils—How obtained and refined—Properties and uses—*Camphoric acid*--How prepared—Properties.

8. *Resins.*—How obtained—General characters—Combinations of resins with alcohol—*Varnishes* of different kinds and for different purposes, how made—Combination of resins with fixed drying oils—*Fat-varnishes*—*Japanning*---Uses in medicine---*Gum-resins*—In what different from resins—Extensive use in medicine—Amber—*Succinic acid*---How prepared---Properties.

9. *Farina* or *fecula.*—Plants which yield it—How obtained by water and by fermentation—Characters—Uses of fecula for the preparation of size, of starch, to give lustre to stuffs, and as a nutritive aliment.

10. *Gluten.*—How obtained—Properties.

11. *Caoutchouc* or *elastic gum.*—How prepared—Properties—Mode of dissolving it—Analysis—Its uses in varnishes, and as a rubber.

12. *The woody fibre.*—Properties—*Pyroligneous acid*—Identical with the acetic.

13. *Colouring matter.*—Variety in its relation to chemical agents according to the diversity of its basis—*Dycing*—*Substantive* colours—*Adjective* colours—Mediating bases or *mordants*—Colours reducible to four—Substances which yield these four colours—Manner of preparing and mixing them—*Lake*—Sir H. Englefield's process for obtaining lake.

14. *Tan*, *tannin*, or the tanning *principle.*—Sources from which it is derived—How extracted in its purity—Arti-

ficial formation of tan—Properties of the natural tan--Of the artificial—Combination with gelatine. *Tanning.*

15. *Wax.*—A vegetable product—Properties of wax—Uses.

16. *The bitter principle.*—How extracted—Characters—Its use in medicine.

17. *The narcotic principle.*—How extracted from opium and other vegetable products—Characters and properties---Its use in medicine.

18. *Suber and suberic acid.*---How extracted from cork---Properties of suberic acid.

RESULT OF THE SPONTANEOUS DECOMPOSITION OF VEGETABLE SUBSTANCES.

1. *Vinous fermentation.*--Principles on which it depends ---Making of wine---Phenomena presented by the fermentation of different kinds of wine---*Brewing*---Germination---Malting---Must of beer---Filtration of the must---Fermentation---Proportion of the ingredients---*Medicated wines.*

2. *Alcohol* or *spirit of wine.*---Distillation of spirits---Refining of spirits---Various means of determining the strength of spirits---Causes of the difference of spirits ---Alcohol, how obtained in a state of purity---Properties of alcohol---Combinations---Uses.

3. *Ether.*---Different kinds of ether. a. *Sulphuric ether* ----How prepared----Properties. b. *Muriatic ether*---How prepared---Properties. c. *Nitric ether*---How prepared---Properties. d. *Acetic ether*---How prepared---Properties---Uses of ether in medicine and in the arts.

4. *Acetous and acetic acids.*---Principal conditions in the formation of acetous acid or *vinegar*---Manufacture of

wine-vinegar----Of vinegar from beer----By distilling animal and vegetable substances----Modifications presented by this acid----Its properties----*Acetic acid*—How obtained pure—-Properties—-Combination with alkalis, earths and metallic oxides—Acetate of potash —Acetate of copper, or *verdigris*—Subacetate of lead, *white lead*—Glacial acetic acid—-Component parts—Acetous acid the most useful of all acids.

B.

ANIMAL SUBSTANCES.

Character of animal substances—Action of warm and cold water on animal substances. *Adipocire*—Action of acids --Of alkalis. *Soap of wool*—Putrid fermentation—Phenomena which attend it—Means of preventing and of stopping putrid fermentation—Distinction of the different species of animal substances.

1. *Animal jelly or gelatine.*—Nearly pure in isinglass—Characters of gelatine—*Glue*—Different sorts of glue —Manufacture of glue—Flanders glue—Mouth glue —Calve's feet glue—Glove and parchment glue—Fish glue or isinglass—Uses of jelly and of glue—Action of tan on gelatine. *Tanning*—Process of tanning.

2. *Albumen.*—How obtained pure from the white of an egg—Properties—Forms a large part of the animal body—Used in clarifying liquids.

3. *Animal mucilage* or *mucus.*—Distinguishing characters of mucus.

4. *Gluten* or *Fibrin.*—From which parts obtained—How separated for experiment—Properties.

5. *Urea.*—How obtained—Characters and properties.

6. *Animal resins.*—How obtained—Properties.

7. *Animal sugar.*—How obtained from milk—Properties.

8. *Animal oils.*—How obtained—*Spermaceti*—Character and properties—*Adipocire*—Its properties.

9. *Animal acids.* a. *Uric acid* or *lithic acid*—How extracted from urine—Most common ingredient of urinary calculi—Properties—Action of acids and of alkalis on it.

b. *Rosacic acid.*—Distinguishing characters.

c. *Amneiotic acid.*—How obtained—Properties.

d. *Lactic acid.*—How obtained from milk—Properties.

e. *Saccholactic acid.*—How formed—Properties.

f. *Sebacic acid.*—How obtained from fat—Properties.

g. *Prussic acid.*—How formed—Properties—Prussiate of iron, *Prussian blue*—General principles of the fabrication of this salt—Materials employed—Process of making it—Analysis.

h. *Zoonic acid.*—Is merely the acetous holding animal matter in solution.

i. *Formic acid.*—Proved recently to be a peculiar acid—Properties.

ERRATA.

Page 3 line 22 for *who* read *which.*
— 4 — 30 for *not any* read *no.*
— 13 — 14 for *banish* read *tarish.*
— 19 — 16 for *Cubush* read *Cutbush.*
— 23 — 2 of the note, for *Vattaism* read *Voltaism.*
— — — 5 of the note, for *Vulta* read *Volta.*
— — — 9 of the note, for *Vespucii* read *Vespucci.*
— 38 — 16 for *in it* read *it.*